

# LANGLEY RESEARCH CENTER STANDARD FOR THE EVALUATION OF SOCKET WELDS

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## I. SCOPE

This specification shall be utilized for the nondestructive evaluation of socket type pipe joints at Langley Research Center (LaRC). The scope of hardware shall include, but is not limited to, all common pipe fittings - tees, elbows, couplings, caps, and so forth - socket type flanges, unions, and valves. In addition, the exterior weld of slip-on flanges shall be inspected using this specification.

## II. INSPECTION TECHNIQUES

At the discretion of the design engineer, standard practice engineer, Fracture Mechanics Engineering Section, Pressure Systems Committee, or other authority, four nondestructive evaluation techniques may be utilized exclusively, or in combination, to inspect socket type welds. These techniques are visual, radiographic, magnetic particle, and dye penetrant. Under special circumstances, other techniques (such as eddy current or ultrasonics) may be required and their application shall be guided by the appropriate sections of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (B&PVC).

## III. VISUAL INSPECTIONS

At the discretion of cognizant authority, socket type weld joints shall be inspected for surface defects using visual techniques.

Visual inspections within the scope of this specification shall be restricted to the weld contour and adjacent pipe and fitting surfaces. Inspections shall be conducted in accordance with the most current editions of the American National Standard Institute (ANSI) Power Piping Code B31.3, Chapter VI, Paragraph 336.4.2 and the ASME B&PVC, Section V, Article 9, with the following modifications:

### A. Inspection Personnel

1. Inspection personnel shall demonstrate the ability to implement inspection techniques, interpret visual data and make quality assessments with respect to the acceptance criteria contained within this document.
2. Inspectors shall have successfully passed an eye examination to demonstrate near-distance acuity such as the J-11 letters on a standard Jaeger Test Chart, in accordance to the following schedule:
  - Under age 35, every 12 months
  - Over age 35, every 6 months

## **B. Inspection Condition**

Unless otherwise specified, all welds shall be contour ground and free of rust, scale, slag or other conditions that would obscure the surface condition.

## **C. Acceptance Criteria**

1. Fillet size - weld fillets shall comply with the requirements of ANSI B31.3 - 1976, Figures 327.4.2, A-C. In lieu of a specified pressure design thickness "t," the nominal pipe wall thickness "Tw" shall be substituted. (See Figures 1 and 2.)
2. Weld Surface
  - a. The weld surface and adjacent base metal shall be free of cracks, incomplete fusion (IF), arc strikes, weld spatter, gouges, mishandling marks, and other sharp surface irregularities. (See Figures 3 and 4.)
  - b. The weld fillet shall blend uniformly into the pipe wall and socket rim. The undercut shall not exceed the lesser of 1/32 inch or Tw/4 (Tw = nominal pipe wall thickness). (See Figure 5.)
  - c. Surface porosity and/or slag is not permitted. (See Figure 6.)
3. Misalignment - unless otherwise specified, axial misalignment, between the pipe and fitting, shall not exceed 5°.

## **D. Inspection Report**

Upon completion of visual inspections, a report shall be furnished containing, as a minimum, the following information:

1. System identification
2. Drawing number
3. Location
4. Sketch or description of each component/weld
5. Material type
6. Surface condition
7. Discrepancies noted
8. Inspector's name
9. Inspection data

#### IV. RADIOGRAPHIC INSPECTIONS

At the discretion of cognizant authority, socket type weld joints shall be inspected for defects using radiographic techniques.

These radiographic inspections shall be conducted in accordance with the most current edition of the ASME B&PVC, Section V, Articles 2 and 22, as modified by the following paragraphs. Any item not specifically herein addressed will revert to the provisions of Section V.

##### A. Personnel Qualifications

All inspection personnel shall be qualified in accordance with the American Society for Nondestructive Testing (ASNT) SNT-TC-1A "Recommended Practice for Nondestructive Testing Personnel Qualification and Certification." Personnel qualified to Level I shall be utilized only under the field supervision of Level II or III inspectors. In addition to the above requirement, radiographic interpreters shall have demonstrated acuity as specified under Section III A 1 and 2 and shall be familiar with weld fabrication techniques.

##### B. Safety

All radiographic inspection operations conducted at LaRC shall be in accordance with applicable Nuclear Regulatory Commission (NRC) regulations ("Notice, Instructions, and Reports to Workers; Inspections," NRC Part 19, April 1975; "Standards for Protection Against Radiation," NRC Part 20, April 1975) and shall, in addition, be in compliance with the NASA Langley Safety Manual, LHB 1710.5, "Ionizing Radiation."

##### C. Surface Preparation

Unless otherwise specified, all welds shall be contour ground and free of surface irregularities which could mask or be confused with discontinuities.

##### D. Direction of Radiation

Each socket weld exposure setup shall be aligned so as to pass the radiation central ray parallel to and in line with the socket rim. (See Figure 7.)

► NOTE: This requirement may, at the discretion of the NASA Technical Monitor, be relaxed to allow the simultaneous exposure of closely spaced weld joints. Three views of each weld joint taken at 60° to each other are the minimum acceptable coverage for pipe having a nominal size greater than 1 inch. For pipe having a nominal size of 1 inch or less, two views of each weld joint taken at 90° to each other are the minimum acceptable coverage. (See Figure 7.)

##### E. Shim Block Thickness, Size, and Material

1. The shim block thickness shall be established for each joint by utilizing the formula:

$$2 Tw + R$$

where

- Tw = the nominal pipe single wall thickness  
 R = the component of weld reinforcement measured perpendicular to the pipe axis at the socket rim. (See Figure 2.)

2. The shim block shall be of sufficient size to allow placement of a penetrometer and identification markers. Shim material shall be radiographically similar to the subject weld/pipe material.

**F. Penetrometer Selection and Essential Holes**

The penetrometer selection shall be based on the calculated shim thickness as follows:

<u>SHIM THICKNESS</u> <u>(2 Tw + R)</u>	<u>PENETRAMETER</u>	<u>ESSENTIAL</u> <u>HOLE</u>
0 thru 0.375	10	4T
Over 0.375 thru 0.625	12	4T
Over 0.625 thru 0.875	15	4T
Over 0.875 thru 1.00	17	4T
Over 1.00 thru 1.50	25	2T
Over 1.50 thru 2.00	30	2T
Over 2.00 thru 2.50	35	2T

**G. Identification Markers**

In lieu of detailed system schematics, weld numbers shall be permanently marked on each inspected joint utilizing low stress stamping. If the radiographic view depicts more than one weld joint, ID numbers shall be included in the image to positively identify each weld. Film printer identification techniques are prohibited. Each radiograph shall, as a minimum, have the following information permanently included in its image:

1. Weld number
2. View number
3. NASA quality assurance (QA) or contract number
4. Radiographic contractor identification
5. Date of exposure

**H. Shim Block/Penetrometer Placement**

The shim block with identification numbers and penetrometer shall be aligned parallel to the subject pipe axis with the penetrometer center adjacent to the socket rim. (See Figure 7.)

## **I. Radiographic Density**

The calculated shim thickness from Section IV E 1 shall be utilized to determine exposure values. Film image density shall be measured through the shim block/penetrameter combination and shall equal  $3.0 \pm 0.5$ . (See Figure 7.)

## **J. Source Strength**

Unless otherwise specified, the radiation source energy shall be equal to or greater than 35 curies for IR 192 and 150 KEV for x-ray machines.

## **K. Scattered Radiation**

To prevent backscatter radiation, all film cassettes shall be backed up with a minimum of 1/16-inch-thick lead sheeting. This sheeting shall be at sufficient size to completely cover the cassette and shall be covered with tape to prevent lead smearing. (See Figure 7.)

## **L. Quality of Radiographs**

All radiographs shall be free of mechanical, chemical, or other blemishes to the extent that they cannot mask, or be confused with, the image of any discontinuity within the area of interest. Such blemishes include, but are not limited to:

1. Fogging
2. Processing defects such as streaks, water marks, or chemical stains
3. Scratches, finger marks, crimps, dirt, static marks, smudges, or tears
4. Loss of detail due to poor screen-to-film contact
5. False indications due to defective screens or cassette faults

## **M. Geometric Unsharpness/Source-to-Film Distance**

Geometric unsharpness of the radiographic image shall not exceed 0.020 inches and the radiation source-to-film distance, unless otherwise specified by the NASA Technical Monitor, shall be not less than 14 inches.

## **N. Acceptance Criteria**

### **1. Cracks**

No cracks of any nature or extent are acceptable. (See Figure 8.)

### **2. Incomplete Penetration (IP)**

IP is defined as the failure of weld material to extend completely into and become integral with the intersection of the socket rim

inner diameter and cylindrical pipe wall. Incomplete penetration is not acceptable. (See Figure 9.)

3. Incomplete Fusion (IF)

IF is defined as an isolated, discontinuous or continuous area of no weld material fusion at the weld-socket, weld-pipe interface, or between consecutive weld passes. Incomplete fusion is not acceptable. (See Figure 10.)

4. Pipe-to-Socket Bottom Gap

A gap of  $1/16$  inch +  $1/32$  inch shall be maintained between the pipe end and socket bottom after welding. (See Figures 2 and 11.)

5. Porosity and Rounded Indications

An individual pocket of porosity shall not exceed the lesser of  $T_w/3$  or  $1/8$  inch in its greater dimensions. Adjacent indications shall be separated by a minimum  $T_w/2$  of sound weld. The summation of diameters for aligned rounded indications shall not exceed  $T_w$  in length for any  $6 T_w$  of weld. (See Figure 12.)

6. Slag and Elongated Defects

The developed length of any single slag inclusion or elongated defect shall not exceed  $T_w/3$ . Adjacent slag inclusions shall be separated by a minimum  $T_w/2$  sound weld. The total cumulative developed length of slag inclusions and/or elongated defects shall not exceed  $T_w$  in any  $6 T_w$  of weld. The width of a slag inclusion shall not exceed the lesser of  $3/32$  inch or  $T_w/3$ . Slag inclusions or elongated defects that infringe upon the root area are not acceptable to any extent. (See Figure 13.)

7. Melt Through

Melt through is defined as a localized area of pipe metal melting and resolidification, usually on the pipe inner diameter. Melt through shall be reviewed on an individual case basis and shall not:

- a. Reduce the nominal pipe wall thickness greater than 12-1/2%
- b. Present severe internal flow restrictions
- c. Include icicle type areas which could become dislodged  
(See Figure 14.)

8. Burn Through

Burn through shall not reduce the nominal pipe wall thickness greater than 12-1/2%.

## 0. Radiographic Technical Log and Interpretation Report

The inspector shall furnish, in addition to the radiographic film, a technical log and interpretation report relative to each inspected weld. The log/report shall contain, as a minimum, the following data:

1. System identification
2. Drawing number
3. Location
4. Sketch or description of each component/weld
5. Material type
6. Pipe nominal wall thickness Tw
7. Weld thickness R
8. Shim block thickness - 2 Tw + R
9. Penetrameter size/essential hole
10. Isotope or x-ray machine, size/type/energy
11. Film type/manufacturer
12. Screen type, thickness, placement
13. Source-to-film distance
14. Exposure time/milliamp-minutes (MAM)
15. Radiographer's name
16. Inspection date
17. Discrepancies noted
18. Interpreter's name
19. Interpretation date

## V. MAGNETIC PARTICLE/DYE PENETRANT INSPECTIONS

At the discretion of cognizant authority, socket type weld joints shall be inspected for surface defects utilizing magnetic particle and/or dye penetrant techniques. When so specified, this work shall be conducted in accordance with the ASME B&PVC, Section V, Articles 7 and 25, for magnetic particles and Articles 6 and 24 for dye penetrants, with the following modifications.

**A. Surface Conditions**

Weld joint surfaces and adjacent areas (within a minimum of 1 inch) shall be free of any irregularities which could mask indications due to discontinuities. Prior to inspection, these areas shall be dry and free of all paint, dirt, grease, lint, scale, welding flux, and splatter, oil or other extraneous matter that could interfere with the examination.

**B. Personnel Qualifications**

Inspection personnel shall be qualified in accordance with ASNT-SNT-TC-1A. Personnel qualified to Level I shall be utilized only under the field supervision of Level II or III inspectors.

**C. Magnetic Particle Technique**

**1. Magnetization Method**

The inspector has the option of utilizing a coil encirclement or yoke magnetization technique.

**2. Field Adequacy**

Magnetizing field adequacy shall be verified through the utilization of a magnetic particle field indicator as illustrated in ASME B&PVC, Section V, Article 25, Section SA-275, Figure 8. This verification shall be conducted at the beginning of each period of work or shift change and as a minimum every 4 hours during the work period.

**3. Coverage**

All surface areas of the weld joint and adjacent pipe and socket material (for a minimum of 1 inch) shall be 100% inspected.

**D. Dye Penetrant Technique**

**1. Dwell Time**

Unless otherwise specified, dwell time shall be not less than 10 minutes.

**2. Temperature**

When the surface temperature of the area to be inspected is outside of the 60° F to 125° F range, the testing procedure shall be qualified as per the requirements of ASME B&PVC, Article 6, Paragraph T-660, "Qualification of Techniques for Nonstandard Temperatures."

**E. Acceptance Criteria**

The following defects shall constitute rejectable conditions:

**1. Cracks**



2. Incomplete fusion (IF)
3. Surface open slag or porosity

**F. Inspection Report**

Upon completion of magnetic particle and/or dye penetrant inspections, the inspector shall furnish a report containing, as a minimum, the following information:

1. System identification
2. Drawing number
3. Location
4. Description or sketch of inspected item
5. Technique
  - a. If there is a dye penetrant, then include:
    - (1) Penetrant type/manufacturer
    - (2) Part temperature
    - (3) Dwell time
    - (4) Cleaning method
    - (5) Development method
  - b. If there is a magnetic particle, then include:
    - (1) Magnetization method
    - (2) Equipment manufacturer
    - (3) AC/DC
    - (4) Current settings
    - (5) Power type/manufacturer
6. Discrepancies noted
7. Inspector's name
8. Date of inspection

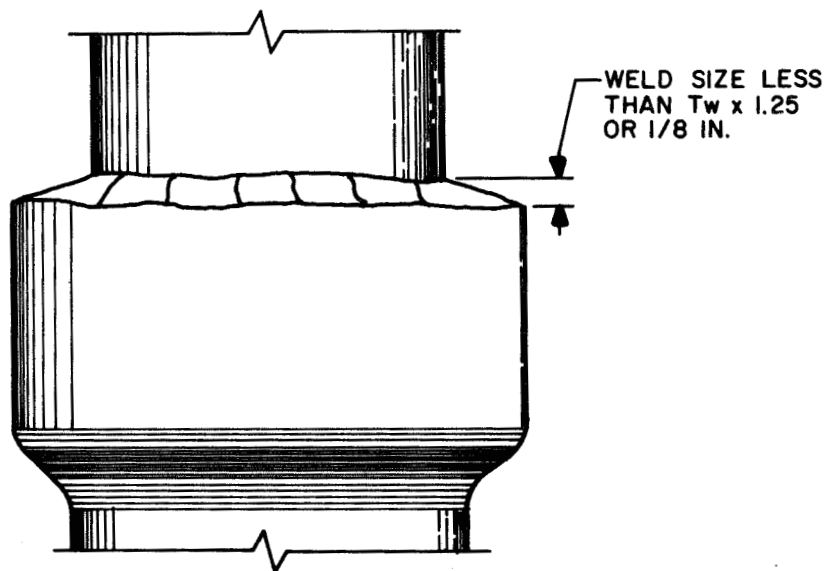
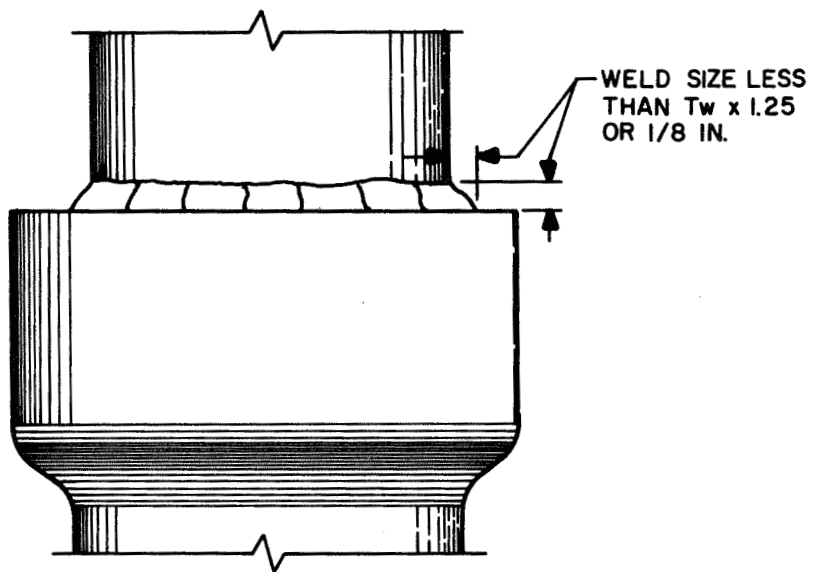


Figure 1. Unacceptable socket weld fillet sizes for components other than flanges.

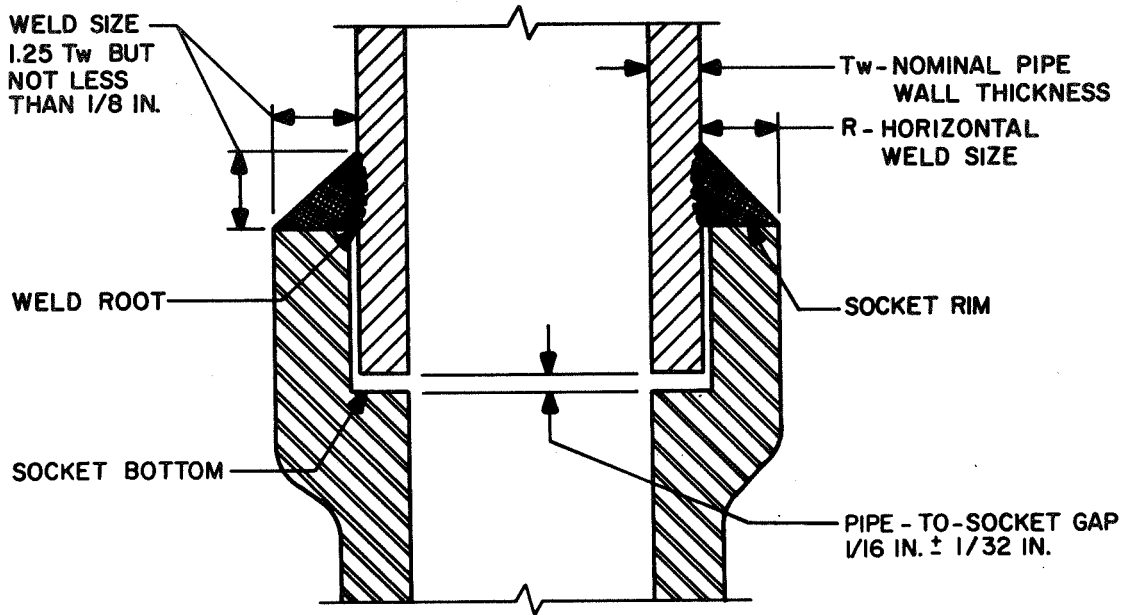


Figure 2. Weld nomenclature and minimum dimensions for socket weld components other than flanges.

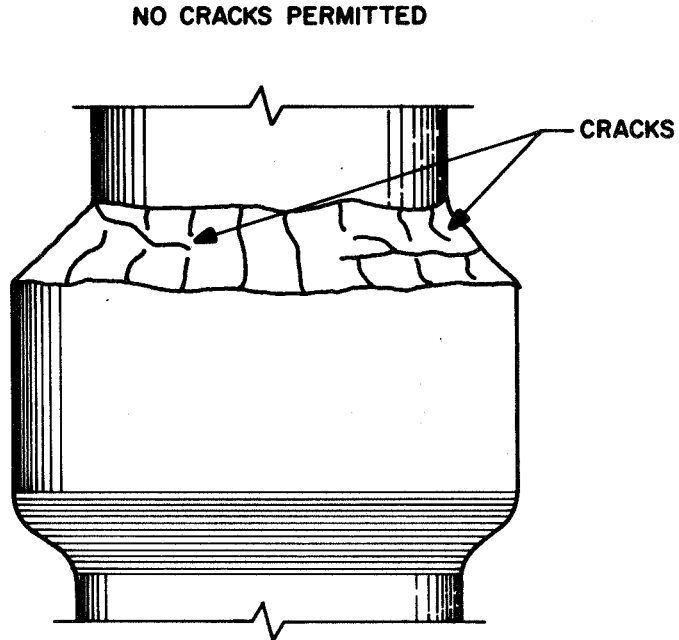


Figure 3. Cracks.

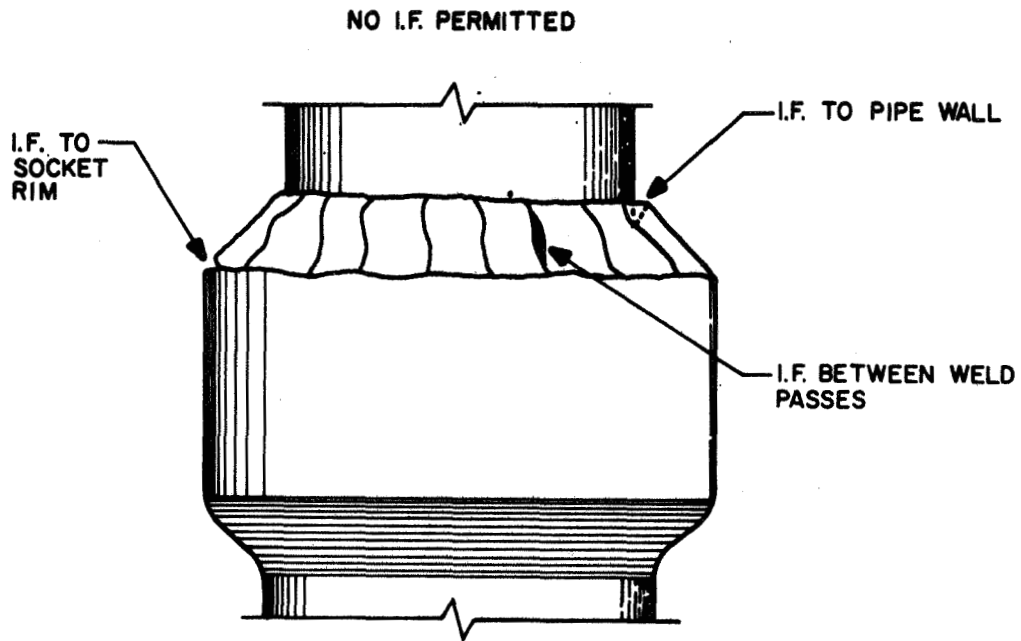


Figure 4. Incomplete fusion (I.F.).

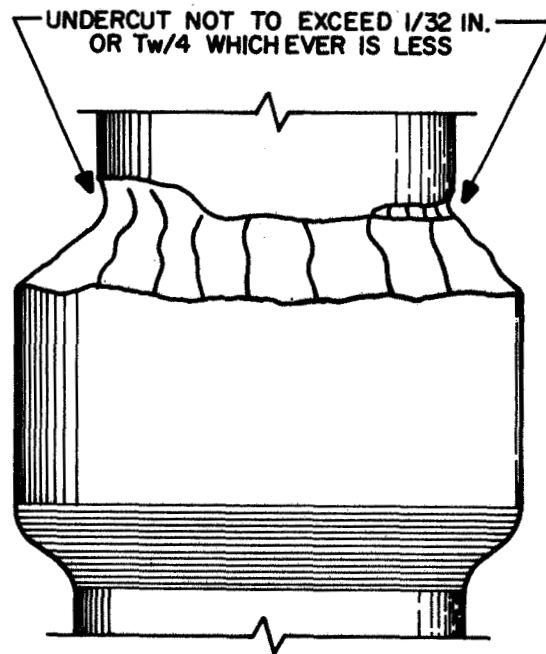


Figure 5. Undercut.

NO SURFACE SLAG OR POROSITY PERMITTED

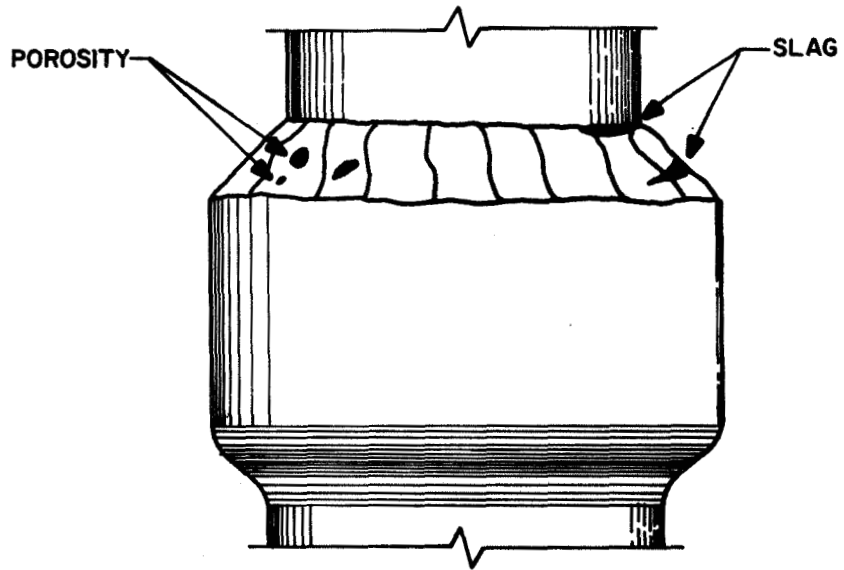


Figure 6. Surface slag porosity.

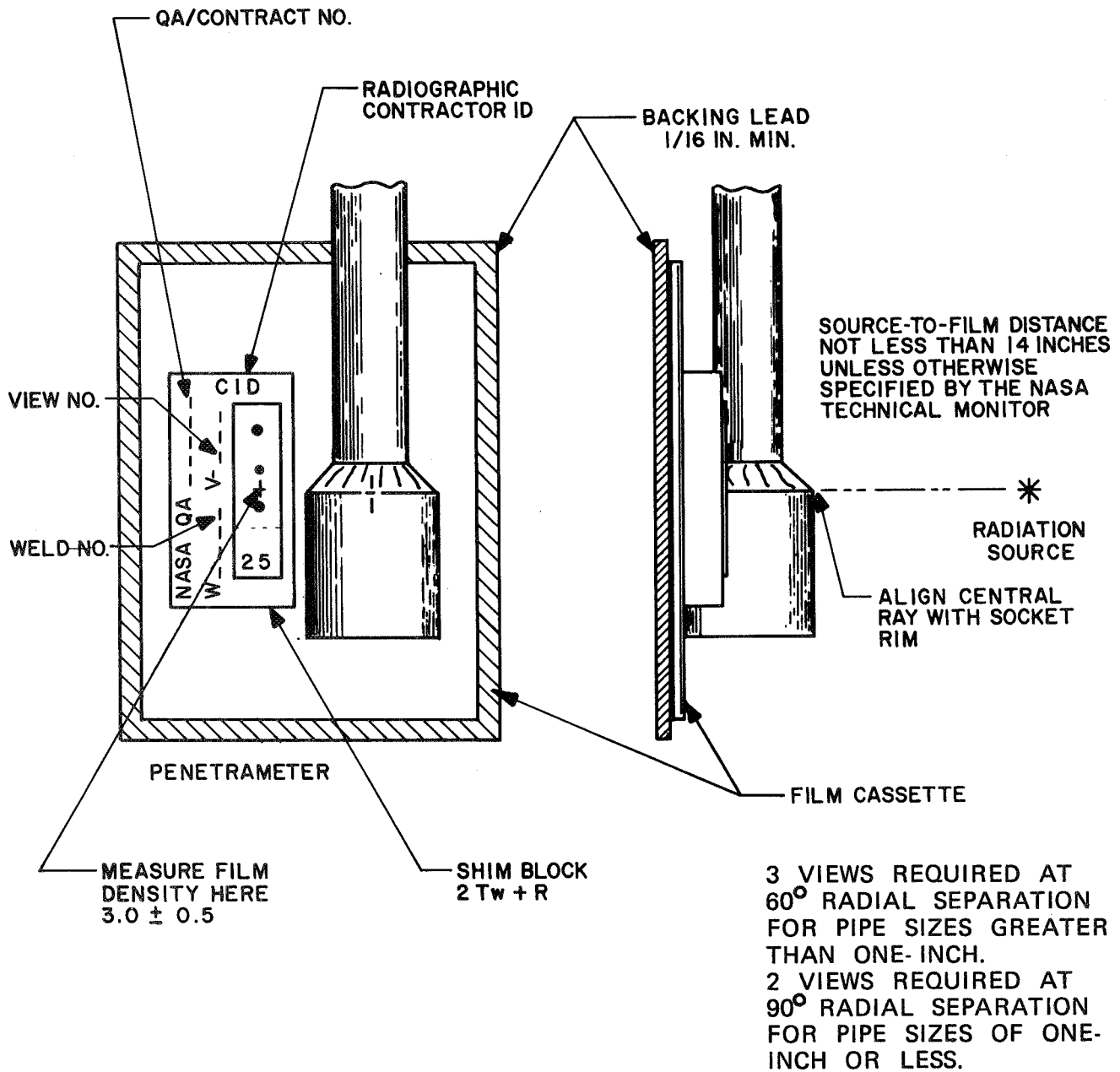


Figure 7. Radiographic exposure technique.

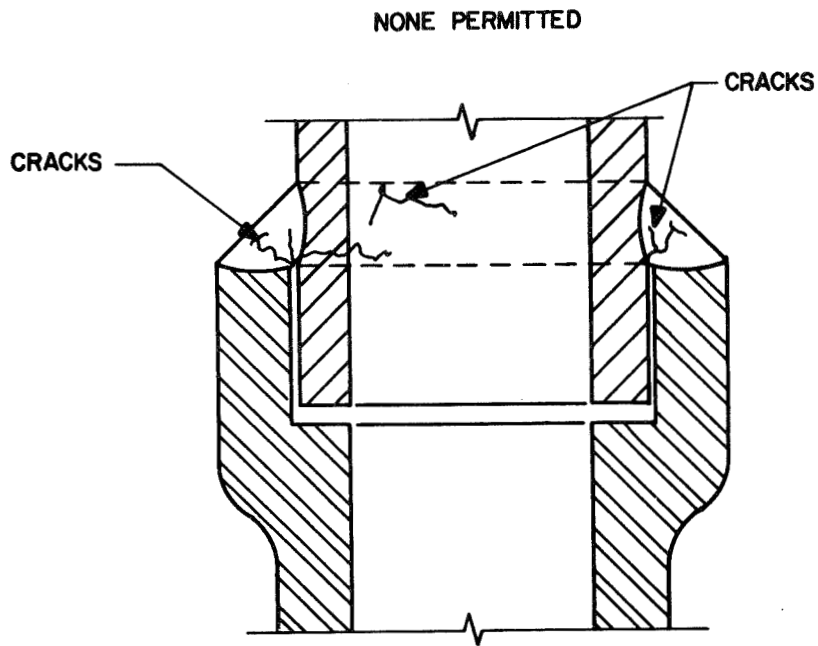


Figure 8. Cracks.

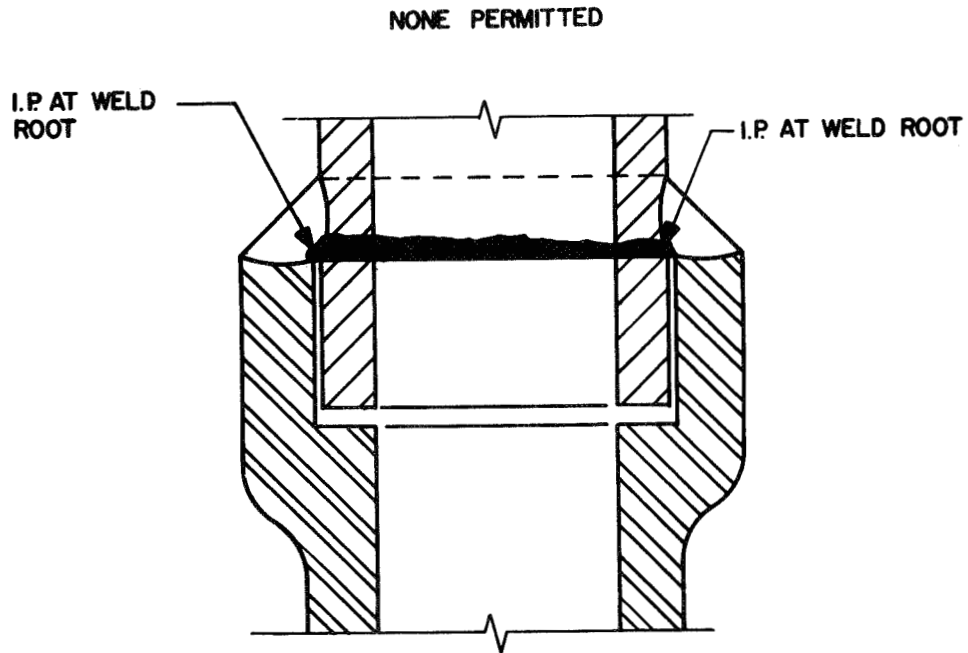


Figure 9. Incomplete penetration (I.P.).

NO I.F. PERMITTED

NOTE - I.F. IS ALSO POSSIBLE BETWEEN  
WELD PASSES

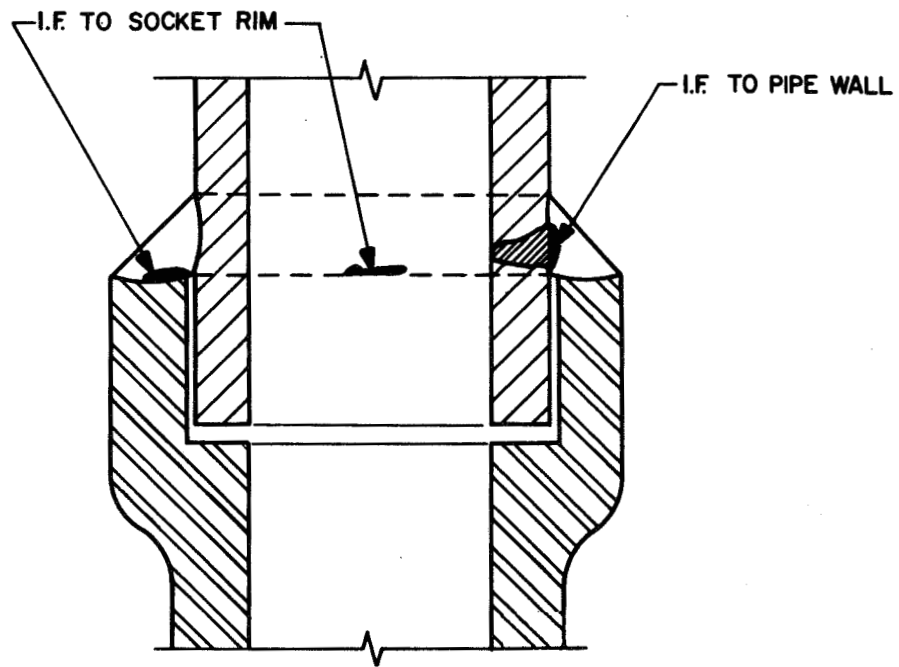


Figure 10. Incomplete fusion (I.F.).



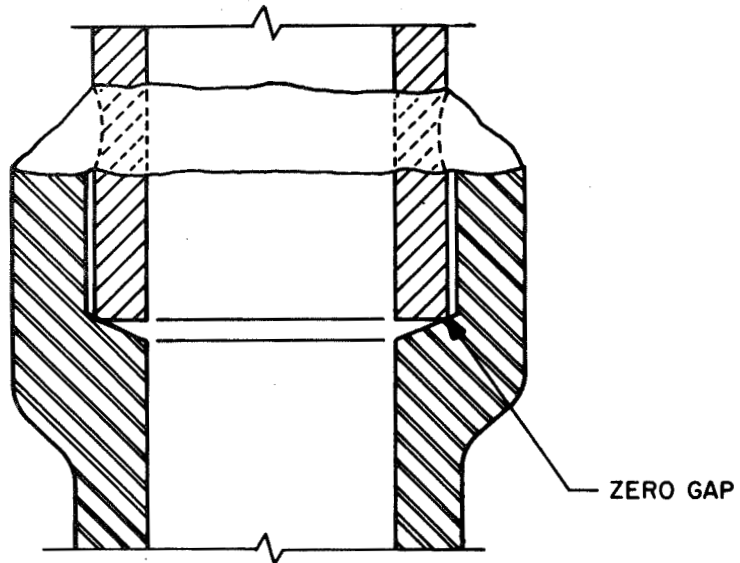
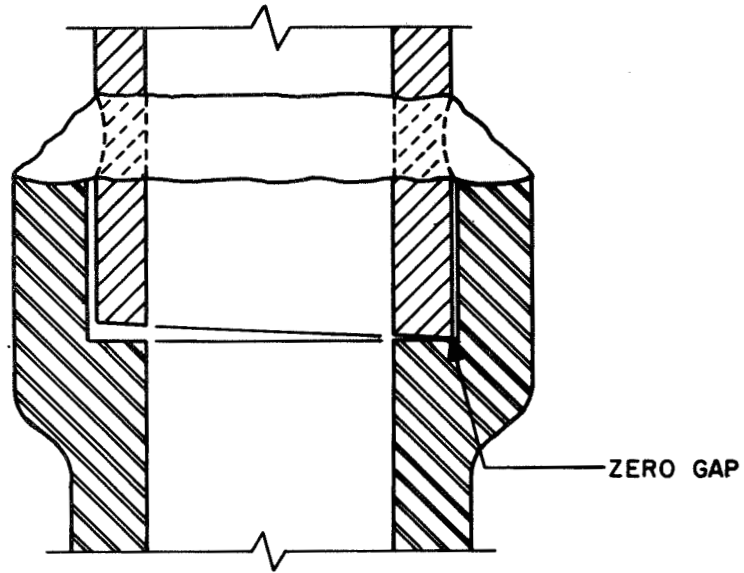


Figure 11. Unacceptable pipe-to-socket gap.

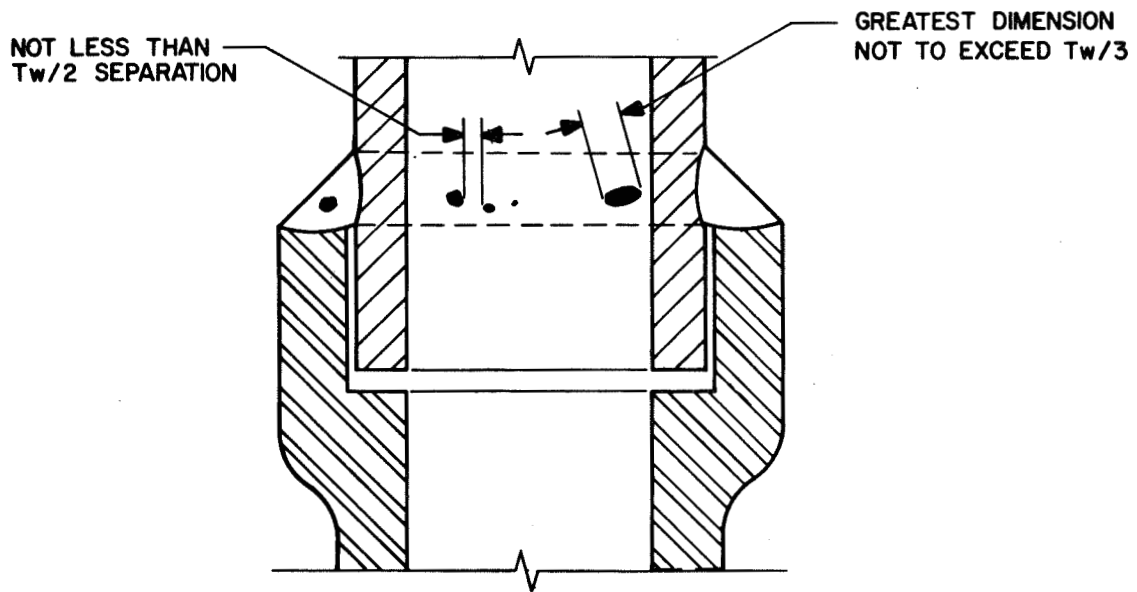


Figure 12. Porosity and rounded indications.

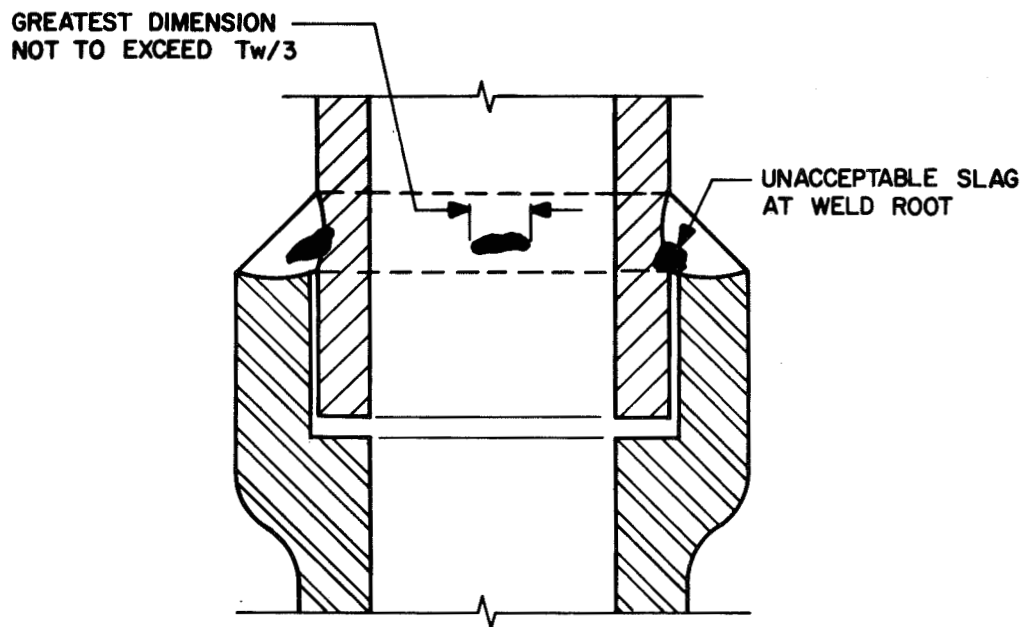


Figure 13. Slag inclusions.

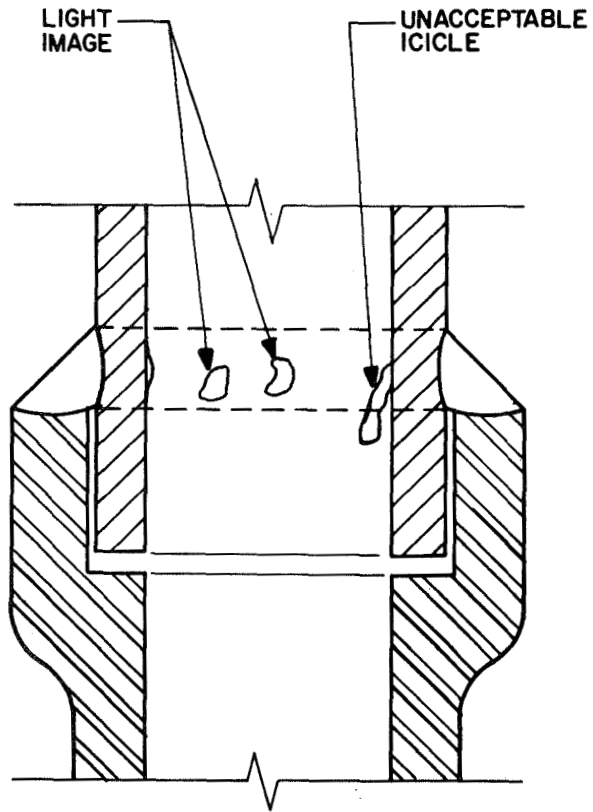


Figure 14. Melt through.